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How Miniature/Microminiature (2M) repair capabilities can reduce the impact of No Evidence of Failure (NEOF) among repairables on the Navy's operations and maintenance account

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THESIS

HOW MINIATURE/MICROMINIATURE (2M) REPAIR CAPABILITIES CAN REDUCE THE IMPACT OF NO EVIDENCE OF FAILURE (NEOF) AMONG REPAIRABLES ON THE NAVY'S OPERATIONS AND MAINTENANCE ACCOUNT

by

Robert C. Barr

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Thesis Advisor: Dan C. Boger

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Today with technical advances and cost reductions in electronics, it has become possible to recategorize many FLRs and DLRs as progressive repairables. This thesis covers the growing problem of No Evidence of Failure (NEOF) among repairables and how Miniature/Microminiature (2M) repair capability can be used to correct this problem. The major objective is to demonstrate how 2M repair capability can save O&MN funding and decrease the Repair Turnaround (RTAT) for repairables. Two NSNs were chosen from the Support and Test Equipment Engineering Program (STEEP) tests performed by SIMA San Diego during1987. A statistical analysis and a Level of Repair Analysis (LORA) were run on both. Research was also conducted on possible changes and uses for shipboard 3-M documentation. The main conclusion of this thesis is that with proper training and implementation, 2M repair capability can save O&MN funding, decrease RTAT for both FLRs and DLRs, and enhance fleet Operational Availability (Ao).

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How Miniature/Microminiature (2M) Repair Capabilities Can Reduce the Impact of No Evidence of Failure (NEOF) among Repairables on the Navy's Operations and Maintenance Account

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ABSTRACT

Today with technical advances and cost reductions in electronics, it has become possible to recategorize many FLRS and DLRS as progressive repairables. This thesis covers the growing problem of No Evidence of Failure (NEOF) among these progressive repairables and how Miniature-Microminiature (2M) repair capability can be used to correct this problem. The major objective is to demonstrate how 2M repair capability can save O&MN funding and decrease the Repair Turnaround Time (RTAT) for repairables. Two NSNs were chosen from the Support and Test Equipment Engineering Program (STEEP) tests performed by SIMA San Diego during 1987. A statistical analysis and a Level Of Repair Analysis (LORA) were run on both. Research was also conducted on possible changes and uses for shipboard 3-M documentation. The main conclusion of this thesis is that with proper training and implementation, 2M repair capability can save O&MN funding, decrease RTAT for both FLRs and DLRs, and enhance fleet Operational Availability (Ao).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

A. PURPOSE

In dealing with the perceived military threats of the world today, the United States government has made the decision to field weapon systems on the absolute cutting edge of technology. The acquisition of increasingly complex weapon systems into the U.S. Fleet has caused an important evolution in maintenance philosophies and supply management procedures. In order to keep Operational Availability (Ao) high, engineers and logisticians have opted in many cases for modularization in system design. The use of modularization has allowed field units to repair downed systems by simply replacing the Printed Circuit Boards (PCBs) and Electronic Modules (EMs) which are suspected to have failed according to the system's repair matrix. This repair philosophy of replacing parts in the dark until a unit is repaired, however, has caused another problem which is known today as No Evidence of Failure (NEOF) among repairables. NEOF rates today are running approximately thirty-percent for all Navy depot level repairables (DLRs) being turned in today. Studies show that approximately thirty million dollars of the fleet operational commanders' Operations and Maintenance Navy (O&MN) Operating Target (OPTAR) funding is being syphoned off into the Navy Stock

Fund (NSF) to induct supposedly Not Ready For Issue (NRFI) material into the repair cycle. This material is subsequently found to be Ready For Issue (RFI) and is returned to the supply system.

Today, as defense funding is reduced, the services must investigate less costly ways of keeping Operational Availability (Ao) high for its systems. The Navy must find ways of using present programs and abilities to minimize the use of available funding while maximizing the fleets Ao. One major way of saving funding is the screening of repairables prior to their passing into the repair cycle.

All items managed by the Navy's wholesale supply system are categorized during the Logistics Support Analysis (LSA) as to what level of maintenance is required to repair an end item. Additionally, the LSA details the numbers of personnel, level of training, and types of support equipment needed to support a system over its life cycle. However, with advancements in technology and the lowering of costs of electronic test devices, it has become possible today to equip most ships with digital test equipment capable of field testing failed PCBs prior to their being turned in for repair. Intermediate Maintenance Activities (IMAs) have been given even greater abilities in testing and repair capabilities than have field level activities. This capability, if implemented and used properly, could turn the tide on the problem of NEOF among repairables.

Fleet commanders could see operational availability remaining high while maximizing the use of their O&MN funding for repairs.

B. METHODOLOGY

The methodology of this thesis will be to research literature and instructions as well as to use test results from IMAs dealing with Miniature/Microminiature (2M) repair and repairables management. This will be done in order to gather data for a statistical analysis. Findings from an experiment performed at the Shore Intermediate Maintenance Activity (SIMA) San Diego, NEOF rates from the Fleet Analysis Center, Naval Weapons Station, Seal Beach, California, and data from SPCC will be used to determine the Coefficients of Correlations (r) between the dollar cost for repair contracts and the cost to a ship's OPTAR account. The Coefficient of Determination (r^2) will also be obtained in order to explain the percentage variation in total dollar value of contracts let for repair of the National Stock Numbers (NSNs) identified by SIMA San Diego. It will also examine the contracts for the repair of these NSNs to determine whether or not full payment is made to the repair depot for items which test RFI during the open and inspect portion of the repair process.

This thesis will also investigate the use of NAVSEA's LORA model as a method of determining what material can be

shifted to 3H Cognizant (COG) material. It will also examine if shipboard 3-M data can be used to compensate for lost procurement information on material shifted to 3H COG.

Finally, this thesis will try to answer the questions: Can the use of 2M repair capabilities at the operational and intermediate levels save money for the Navy? Which items should be chosen for migration to 3H COG? Can shipboard 3-M documentation be used to compensate SPCC for lost procurement usage data for items repaired at the operational and intermediate levels?

C. ORGANIZATION

Chapter III will discuss past projects in connection with 2M repair capability at the operational and intermediate levels. It will also provide the data with which the statistical analysis for the Coefficient of Correlation (r) and the Coefficient of Determination (r^2) will be performed and their limitations discussed. The methods of repair contracting used by SPCC will also be investigated to determine how money paid for repairs is used and what happens to payment made for the repair of ready for issue items. The focus of the analysis will be whether money can be saved for the Navy by using 2M repair capability to a greater extent at the organizational and intermediate maintenance levels. Chapter IV will discuss the NAVSEA LORA models as they are today and how they might

be used to help SPCC locate material for migration to 3H COG. In Chapter V, the afloat 3-M system is investigated to determine how the NAVSUP form 4790.2K could be used to generate previously unavailable usage data for SPCC on material coded as a progressive repairable. The final chapter will draw conclusions about the use of 2M repair capability and make recommendations dealing with COG migration, the NAVSEA LORA model, and the 3-M maintenance documentation.

II. BACKGROUND INFORMATION

The acquisition of repair parts for a new system is a long and complex ordeal. The decisions as to what material is to be procured as spares for supportability and the classification of these items are made as early in the systems acquisition process as possible. To ensure that these decisions are the best and the most appropriate for a specific system, the Program Manager (PM) is required to create, maintain, and refine an Integrated Logistics Support Plan (ILSP) beginning in the Concept and Exploration Phase and maintain it throughout the entire acquisition process. Integrated Logistics Support (ILS) is described as "...a unified and iterative process that integrates logistics support considerations and maintenance techniques {e.g., Reliability Centered Maintenance (RCM)} into the design effort in order to obtain reliable, maintainable, transportable, and supportable equipment at a minimum cost of ownership throughout the equipment's life cycle." [Ref. 9:p. III-3]

In the Program Management Office (PMO), the Logistics Manager (LM) is responsible for the direction of the ILS. He is guided in this task by numerous directives from higher authority that affect a wide range of supply and maintenance functional areas. Item classification and

maintenance level determination are made for each item of supply during the acquisition process.

A key step in the ILS is the Logistic Support Analysis (LSA). The LSA serves as "...a continuing dialogue between the weapon system designer and the logistician..." with the prime objective of ensuring "...the acquisition of operationally effective and supportable equipment at a minimum (or optimal) cost through the system's life cycle." [Ref. 1:p. 2-10] Figure 1 portrays the primary elements of the LSA process.

SYSTEM REQUIREMENTS

|

V

DEFINE QUALITATIVE/QUANTITATIVE
LOGISTIC SUPPORT OBJECTIVES

V

DEVELOP DESIGN PARAMETERS FOR USE IN:
DESIGN COST/OPERATIONAL AVAILABILITY/CAPABILITY TRADEOFFS
DEVELOPMENT OF LOGISTIC SUPPORT CAPABILITIES
RISK ANALYSES

V

EVALUATE THE EFFECTS OF ALTERNATIVE HARDWARE DESIGN ON:
SUPPORT COSTS; OPERATIONAL READINESS
IDENTIFY: KNOWN SCARCITIES; CONSTRAINTS; LOGISTIC RISK
APPRAISE DESIGN AND HARDWARE TO VERIFY:
SUPPORTABILITY FEATURES
(I.E. ACCESSIBILITY AND COMPATIBILITY OF TEST EQUIP.)

V

PROVIDE (AS DESIGNS BECOME FIXED)
TIMELY/VALID DATA FOR ALL ILS AREAS

V

IMPLEMENT LOGISTICS ACTIONS

MAINTENANCE PLANNING	FACILITIES
PROVISIONING	STORAGE/STOWAGE
PERSONNEL AND TRAINING	ALLOWANCE LISTS
TECH PUBS	MANNING

FUNDING

Figure 1. LSA Process [Ref. 9:p. III-5]

A specific trade-off analysis undertaken as part of the LSA is the Level of Repair Analysis (LORA). "The purpose of the Level of Repair Analysis is to aid establishment of least cost maintenance actions and to influence equipment design." [Ref. 1:p. 2-11] Using the LORA, the LM decides: "...(a) if an item should be repaired; (b) if so, at what maintenance level (organizational, intermediate, or depot); or (c) if the item should be discarded." [Ref. 9:p. III-7] Figure 2 depicts the steps in conducting a LORA.

```
_______________________________________________________________
                      ILS PLANNING POLICY
_______________________________________________________________
                           |
                           V
_______________________________________________________________
                  LSA DATA ELEMENTS
            UNIT COST, SUPPORT EQUIPMENT, PERSONNEL
_______________________________________________________________
                           |
                           V
_______________________________________________________________
    REPAIR | LORA/CONTRACTOR RECOMMENDATIONS  |   DISCARD
       |---|NAVY ECONOMIC/NONECONOMIC CRITERIA|-------|
       |                                              |
       V                                              V
 REPAIR CATEGORY                                   DISCARD
 |     |       |                                      |
 |    IMA      |                                      |
DEPOT  |       |                                      |
|      | ORGANIZATION                                 |
V------V-------V--------->  INPUT TO LSA       <-------V
                                 |
                                 V
                   _____________________________
                      FINAL HARDWARE DESIGN
                                 |
                                 V
                   _____________________________
                           LSA RECORD
                                 |
                                 V
                   _____________________________
                      OPERATIONAL HARDWARE
```

Figure 2. Level of Repair Analysis [Ref. 9:p III-8]

Information gathered on equipment concerning reliability, availability, and maintainability factors in these early phases of the acquisition process are used by the LM to create the overall system maintenance plan and the Source, Maintenance, and Recoverability (SM&R) codes for the different parts comprising that system.

> SM&R codes communicate maintenance and supply instructions to logistics support echelons and user commands. Specifically, Joint Service uniform SM&R codes identify the manner of acquiring support items for the maintenance, repair, or overhaul of end items; indicate the maintenance levels authorized for performing the required maintenance functions; and prescribe the disposition action for unserviceable support items. The initial assignment of SM&R codes takes place prior to provisioning to permit the procurement of a range of spares and repair parts to support new weapons, systems, and equipment. The SM&R code is made up of a six-digit code. The first two positions consist of a two-position source code. The source code indicates the manner of acquiring an item for maintenance, repair or overhaul of end items. The second two positions represent a maintenance code. The maintenance code indicates the lowest maintenance level authorized to remove, replace, and use the item. The fifth position is held by the recoverability code. The recoverability code amplifies the information provided by the maintenance code and indicates the lowest level of maintenance authorized to perform all possible repair actions and to dispose of the unserviceable support item. The sixth position of the SM&R code is reserved for service options. In the Navy, it is used to provide special instructions and for internal management purposes. [Ref. 9:pp. III-12-16]

The combination of a parts maintenance coding and recoverability coding identifies the material as either a consumable, Field Level Repairable (FLR), or Depot Level Repairable (DLR). A consumable is a part that cannot be economically repaired (i.e., it is less costly to replace than repair). Material is designated as a FLR when it is

less costly to provide the required training, equipment, and expertise at either the organizational or intermediate level to make repairs to an item. DLRs have been so designated because it has been determined that it is more economical to repair at either an organic (Navy owned) or commercial repair depot. Appendices B, C, and D list the most frequently used third, fourth, and fifth position SM&R codes used today to identify an item's maintenance and recoverability by the ICPs.

Material is further segregated by the Inventory Managers (IMs) through the use of Material Condition Codes (MCCs). The MCCs group items together into specific categories for reporting purposes. Appendix E lists commonly used MCCs and their meanings.

As present-day military hardware has developed into highly complicated weapon systems, engineers have relied more and more on the concept of repairable modules to meet requirements for systems availability and component reliability goals. Modularization has greatly facilitated the ease of maintenance and repair at the organizational level. However, this trend towards modularization has resulted in a corresponding increase in the number, value, and significance of repairable items. Repairables today now comprise an important segment of the workload of all major Navy industrial activities. Quick and accurate component rework is a major contributor to the effectiveness,

support, and readiness of Navy ships and aircraft. However, this augmented demand for DLR repairs has outstripped the organic depot capabilities, and the Navy has had to resort to commercial activities to maintain DLR Repair Turnaround Times (RTATs). Predetermined forecasts of RTATs is a dominant force affecting the operational availability and life cycle cost of a weapon system. Table 1 below reflects the growing trend towards commercial contracts for DLR repair at one of the Navy's Inventory Control Points (ICPs), Ships Parts Control Center (SPCC).

TABLE 1. ORGANIC AND COMMERCIAL REPAIR TOTALS [Ref. 12:p. 1]

Fiscal Year	Organic Repair$	Commercial Repair$	Total Repair$
FY-81	66M	44M	110M
FY-84	88M	149M	237M
FY-87	106M	213M	319M

In response to public outcry against perceived wasteful government spending and the exorbitant cost of today's weapon systems, coupled with pressure from the CNO to attain advertised systems operational availability goals, the Navy has sought to improve its contracting and logistical support processes. The massive increase in the number of DLRs in the Navy's inventory has necessitated streamlining and improvement in all facets of DLR management.

One change that has occurred in the past few years has been in the way DLRs are handled at the organizational

level. There is the new Advanced Tracking and Control (ATAC) program for central management of DLRs and the new signature control incentives involving all repairables movement. However, one of the most aggressive of all the new incentives dealing with DLRs is the move toward progressive repairs of DLRs. Prior to this concept, repairables were divided into the groupings of FLRs and DLRs. Under the progressive repair concept, organizational and intermediate level activities have been outfitted with Automatic Testing Equipment (ATE), Test Program Sets (TPSs), and Miniature/Microminiature (2M) repair stations. This has allowed these facilities for the first time the ability to inspect and repair repairables which before could only have been tested at a higher maintenance level. Progressive repairables are determined by analyzing the fourth and fifth positions SM&R codes assigned. Items which are considered progressive FLR are coded with an F, G, H, or O in the fourth position of the SM&R code and either a G or a H in the fifth position of the SM&R code. Progressive DLRs carry a fourth SM&R position of G, H, or O and a fifth position of D.

The confusion concerning repairables results mainly because the information is not readily apparent to the repair technician and storekeeper. All information dealing with an item's SM&R code is located in one and only one location, and that is the command's COSAL. An item coded

1HD is known to be a FLR from its COG and MCC, and an item coded 7HH is known to be a DLR from its coding. In fact, both items may be progressive repairables, but this would never be known unless their SM&R codes are reviewed.

To correct the ambiguity among FLRs, on 10 April 1985, Commander, Naval Supply Systems Command (NAVSUP) authorized the establishment of the new cognizance symbol 3H for use at SPCC and ASO. 3H material would still be FLRs just as they had been as 1H material, but the ambiguity of the MCC D would be placed to rest. The technician would now be able to look at the COG and tell whether he had condemnation authority or not (i.e., 1H yes, 3H no).

Continued improvements and addition of new TPSs, technological advances in electronics, and the lowering of costs to the point where each ship can be provided with digital test equipment has furthered the abilities of organizational and intermediate commands to test and repair DLRs at below depot level. The equipment presently being provided by Naval Sea Systems Command (NAVSEA) to all afloat units for this purpose is the AN/USM-465, also known as the GENRAD 2225 Portable Service Processor (PSP). The 465 is presently capable of testing hundreds of different Printed Circuit Boards (PCBs) from twenty-nine different weapon systems. The only requirement for the afloat units is the changing of the test program, which gives the test parameters for the PCB being tested and at

times certain hardware changes. Intermediate Maintenance Activities (IMAs), in addition to the AN/USM-465, have been issued PHOENIX-530 units and analog test units. The PHOENIX-530 is capable of checking PCBs for an additional nine weapon systems.

While Miniature/Microminiature (2M) repair at the organizational level has been highly effective in decreasing Repair Turnaround Times (RTAT) and reducing cost to TYCOMs and field level OPTAR accounts, there has been an alarming increase in the number of No Evidence of Failure (NEOF) material appearing at repair depots among those DLRs which can be screened and often repaired at the organizational and intermediate levels. This situation has had several effects:

1. It has reduced local OPTAR accounts for material turned in that is Ready For Issue (RFI).

2. It has added work to repair depots which are already overworked.

3. It has increased the RTAT for many progressive repairables.

III. MINIATURE/MICROMINIATURE (2M) REPAIR CAPABILITY

A. BACKGROUND

> In Fiscal Year (FY) 1978 Commander, Naval Sea Systems Command (COMNAVSEASYSCOM) initiated the Support and Test Equipment Engineering Program (STEEP) to test the feasibility of screening, testing, and repairing Electronic Modules (EMs) and PCBs. The pilot program involved screening, testing, and repairing of EMs/PCBs for both COMNAVSEASYSCOM and Commander, Naval Electronic Systems Command by using Automatic Test Equipment (ATE) located at selected shore intermediate maintenance activities. [Ref. 4:p. 5]

Since 1978, one hundred forty-eight ATEs and approximately six hundred seventy TPSs have been purchased for the fleet and intermediate repair levels. An additional one hundred ATEs have been authorized but have not as yet been placed in service. Two types of TPSs are presently in use at the organizational and intermediate levels. The first type of TPS is a screening only TPS. "Screening only TPS identify whether the EM/PCB are ready for issue or defective (i.e., go/no-go)." [Ref. 4:p. 2] The second type of TPS is called a diagnostic TPS. "...Diagnostic TPS not only to identify whether EM/PCBs are go/no-go, but also fault isolate defects to enable technicians to make necessary repairs." [Ref. 4:p. 2]

Miniature/Microminiature repair technicians can carry four different Navy Enlisted Classifications (NECs). Miniature repair technicians carry a NEC of 9527, and

microminiature repair technicians carry the NEC 9526. A 2M repair technician carries both NECs. 2M inspectors carry NEC 9503, and 2M instructors carry NEC 9509. Presently, 2M NECs are considered secondary NECs and are not mandatory for ship's repair personnel being assigned to a ship with either a 2M repair station or an AN/USM-465 test set.

Afloat requests for either an ATE (AN/USM-465) or a 2M repair station are forwarded to NAVSEA code 06Q for consideration. 2M repair stations presently cost approximately $6,000.00 to supply, and an AN/USM-465 costs approximately $55,000.00.

According to the 1983 Western Region Navy Audit Report,

> The dominant cost savings were attributable to major reductions in supply pipeline costs resulting from a lowering of false removal rates applicable to EMs/PCBs ambiguity groups. Ambiguity groups of EMs/PCBs within a principle electronic system usually consist of three to five EMs/PCBs; and when one EM/PCB fails, the entire group is considered defective.... [Ref. 4:p. 5]

Repairable material at SPCC is presently classified as shown in Table 2.

TABLE 2. NUMBERS OF DLRs BY CLASSIFICATION

	Applicable SM&R Codes	No. of Line Items
Depot Level	DD	17,678
Progressive Depot Level	2D, 3D ,GD, HD, OD 2L, 5D, 6D, 3L	136,917
Progressive Field Level	HH, 2G, OG, GG 2H, OH, OF,	89,918
Field Level	2Z, OO	23,231

As can be seen from the data presented in Table 2, thousands or EMs/PCBs are eligible for review/repair at the organizational and intermediate levels. These parts also constitute a large portion of the items which fall into the previously mentioned ambiguity groups. Today's problem of NEOF is partially due to material that is not being properly screened at the organizational and intermediate levels prior to being turned in for depot repair. Money charged to OPTAR accounts for repair of NEOF DLRs is paid either entirely or partially to the repair depot with the remainder being applied to the Navy's revolving stock fund account.

A 1985 Naval Sea Combat Systems Engineering Station report stated that "...sixty-four ships participating in their survey estimated that 980 Casualty Reports (CASREPs) were averted as a direct result of the 2M repair program." [Ref. 2:p. 2] In 1984, the USS CARL VINSON (CVN 70) conducted a study under the direction of Commander Naval Aviation Forces Atlantic Fleet (COMNAVAIRLANT) and Naval Sea Combat Systems Engineering Station (NAVSEACOMBATSYS-ENGSTA) Norfolk, Virginia to perform as many 2M repairs as possible during its 1984 deployment. The results of that test period are shown in Table 3.

TABLE 3. COST AND SAVINGS STATISTICS [Ref. 3:p. 7]

1. During the POM period of November and October 1984, the following statistics apply:

Man hours expended :	252.30 hrs.
Parts expenditure:	$3,425.98
Turn in cost of repaired cards:	$162,066.07
Savings:	$158,665.21
Number of jobs:	71

2. During the deployment, the following statistics apply:

Man hours expended:	852.00 hrs.
Parts expenditure:	$7,507.23
Turn in cost of repaired cards:	$258,094.43
Savings:	$251,214.97
Number of jobs:	236

3. The average turn-around time for equipment brought to 2M for repair follows:

Component replacement only:	1.5 hrs.
PCB repair:	36.0 hrs.
Local manufacture (Cables, etc):	48.0 hrs.

B. NO EVIDENCE OF FAILURE TESTING

Testing for NEOF among repairables started in 1978 under STEEP. "In the first 15 months of the program, 75 percent of all EM/PCBs sent to SIMAs for repair were found to have no defects." [Ref. 4:p. 5] A NAVSEA funded investigation of NEOF for fleet level turn-ins of PCBs conducted by Naval Weapons Station, Seal Beach noted that "...Based on an average "net" cost of $873 for each board and an average NFE rate of 38% the resulting annual OPTAR cost to the Navy, due to NFE boards, is $10,615,000.00." [Ref. 6:p. 1] A further review showed that many of the items subject to NEOF were not covered by this study. "Therefore, a more realistic figure for NFE cost would be

three times higher or in excess of $30,000,000.00 per year." [Ref. 6:p. 1]

Two more recent studies conducted by SIMA San Diego gave the results displayed in Tables 4 and 5.

TABLE 4. NEOF RESULTS FROM AUGUST 1987 TEST [Ref. 7:p. 1]

NSN	Total Tested	Condition "A"	Condition "F"	NEOF Rate
5895-00-395-0292	2	1	1	50%
5895-00-395-0295	13	6	7	46%
5895-00-412-8615	29	21	8	72%
5895-00-412-8618	1	0	1	0%
5895-00-395-8620	13	7	6	54%
5895-00-535-8247	10	6	4	60%
5999-01-042-3396	25	11	14	44%
5840-01-084-8764	7	2	5	29%
Totals	100	54	46	54%

TABLE 5. NEOF RESULTS FROM DECEMBER 1987 TEST [Ref. 8:p. 1]

NSN	Total Tested	Condition "A"	Condition "F"	NEOF Rate
5895-00-412-8615	2	2	0	100%
5895-00-412-8620	8	4	4	50%
5845-00-450-1852	18	14	4	78%
5825-00-321-0671	30	4	26	13%
Totals	58	24	34	41%

SIMA San Diego estimates that $21,063.00 from the first test and an additional $6,348.00 from the second test could have been saved by ship OPTAR holders if the material had been screened prior to being turned in for repair. During the December 1987 test, SIMA San Diego also conducted repairs on NSNs 5845-00-450-1851 and 5825-00-321-0671 resulting in an additional savings of approximately $10,486.76. The test cost data follows in Table 6.

TABLE 6. REPAIR COSTS AT SIMA SAN DIEGO [Ref. 8:p. 1]

NSN	No. "F"	No. Repaired	Total Parts Cost
5845-00-450-1851	4	4	$37.92
5825-00-321-0671	26	17	$39.32
		Total Cost	$77.24

In August 1987, NAVSEACOMSYSENGSTA Norfolk, Virginia reported that average 2M repair actions totaled $243.91. "Supply cost and labor cost are based on standardized costing factors. Supply cost is based on $60.24 per requisition or supply actio. The supply cost for the typical 2M action is based on an average of one requisition, therefore the typical supply cost is $60.24. Labor cost is based on $13.48 per man-hour. For the typical 2M action the labor cost is the 11.9 M-H average labor per 2M action times $13.48 which is $160.41." [Ref. 5:p. 9] "...A conservative estimate is a savings per 2M action of approximately five times the cost calculated per 2M action. A more significant advantage of the 2M repair is the ability to repair items and return a system to service expeditiously when otherwise there would have been a delay awaiting parts." [Ref. 5:p. 10]

C. REGRESSION ANALYSIS

In order to run a regression analysis, one must have at least two sets of data which can be correlated against each other. Appendix F lists the ten NSNs which comprise the

original pool from which the two NSNs for the regression analysis were chosen. Each DLR data base contains five main sets of data which were considered as possibilities for the independent and dependent variables required to conduct a regression analysis. These data sets are:

1. Standard price. The standard price is the price which SPCC considers as its replacement cost. It is based on the latest price paid for a new unit plus a surcharge. Unfortunately, new orders are not performed every year so the standard price at times is based on pricing which may be several years old. This causes a problem for SPCC when commands who order DLRs without a carcass turn-in are charged the standard price and this price is not sufficient to cover the cost of a new item or it is discovered to have been too high of a replacement price estimate.

2. Repair price. There are two types of repair pricing used at SPCC today. The first is the historical price which is the cost of the last repair action to be made on a DLR. The second is the current repair price which SPCC would currently have to pay for repairs on the item today. It is this second type of repair pricing which is used for the regression analysis.

3. Net price. The net price of an item is based on the historical cost to repair the item plus a surcharge. The repair cost figure, however, is once again the cost of the last repair action performed on that NSN. This, too, has caused problems for SPCC.

4. Demand quantity. The demand quantity is the historical number of items requisitioned by end users of an item. This figure can be unduly affected by either the fact that an item has a high NEOF rate or by the fact that it is a progressive DLR and has a high IMA repair accomplish rate. In either case, the demand quantity registered by SPCC can be in error. A high NEOF rate causes an inflated demand reading, and a high IMA repair accomplishment rate on progressive DLRs can rob SPCC's data base of demand information. This is because at present SPCC can only use procurement data to determine demand from the fleet. Chapter five of this paper will discuss a possible solution to this problem.

5. Repair quantity. Repair quantity is the number of items which are repaired during a period of time. Here, too, there have been some problems. SPCC does not repair the same number of items each year as have been ordered and turned in. Instead, a complicated math model is used to forecast the quantity of an item which will be required, and repairs and reorders are based on this quantity. Any remaining Not Ready For Issue (NRFI) carcasses are stored until required for repair processing.

The items considered as eligible for the regression analysis were limited to those items selected by SIMA San Diego for their two repair tests in August and December of 1987. All pertinent information on these items is listed in Appendix F. As discussed earlier, IMAs are supposed to possess repair capability for progressive repairables, and as a result progressive DLRs were eliminated from the pool of items available for analysis. Therefore, the items considered as eligible were those which were SM&R coded as depot/depot repairables and had a proven repair capability by SIMA San Diego. The two NSNs 5845-00-450-1852 and 5825-00-321-0671 fit the above requirements. Both of these items are coded as depot/depot level repairables, and both had been repaired by SIMA San Diego during their December 1987 test.

With the NSNs selected, only the independent and dependent variables were left to select. For the purpose of the regression analysis, the yearly net pricing and depot repair pricing for the two NSNs were chosen as the dependent and independent variables respectively. The

reasoning behind this is that net pricing is built upon the repair pricing plus a surcharge. Therefore, a positive correlation was expected. The data used for both items in the regression analysis are displayed in Tables 7 and 8, and the findings of the regression analyses are shown in Table 9 on the following page.

TABLE 7. REGRESSION ANALYSIS DATA NSN 5845-00-450-1852

FY	Net Price	Depot Charge
85	$501.00	$315.00
86	$469.00	$335.00
87	$476.00	$418.00
88	$108.00	$400.00

TABLE 8. REGRESSION ANALYSIS DATA NSN 5825-00-321-0671

FY	Net Price	Depot Charge
85	$770.00	$502.00
86	$727.00	$519.00
87	$737.00	$435.00
88	$596.00	$515.00

TABLE 9. REGRESSION ANALYSES RESULTS

For NSN 5845-00-450-1852

Constant	1,042.549
Std Err of Y Est	202.377
r^2 (Coefficient of Determination)	0.22337511
r (Coefficient of Correlation)	- 0.4726258
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	Std Err of Coef.
- 1.78215	2.349729

For NSN 5825-00-321-0671

Constant	1,038.639
Std Err of Y Est	88.06084
r^2 (Coefficient of Determination)	0.1182317
r (Coefficient of Correlation)	- 0.3438483
No. of Observations	4
Degrees of Freedom	2
X Coefficient(s)	Std Err of Coef.
- 0.67202	1.297716

Note that the Coefficients of Correlation for both NSNs are (-.47) and (-.34) respectively. The fact that both NSNs have negative Coefficients of Correlation means that as their depot repair prices have increased, their net prices have decreased. The Coefficient of Determination for NSN 5845-00-450-1852 shows that only 22.34% of the variation in price for a depot repair can be explained by the different net prices charged to the fleet each year, and for NSN 5825-00-321-0671 only 11.82% of the change in the net price can be explained by the movement in the NSN's repair pricing.

With such poor correlation between their net and repair prices, the regression formulas for these two NSNs will not give very accurate predictions for future prices. A discussion with personnel in the contracting and pricing departments at SPCC shed the following light on the above findings:

1. The standard price charged to customers is based on the most recent purchase price paid for a new item.

2. The net price, however, is based on the historical price for repair of the NSN plus a surcharge. In many cases, this price may be very old or come from several different repair sources, and because of their different methods of billing for repairs it is often difficult for SPCC to have a set repair price on which to base an item's net price.

3. The repair contract types used at SPCC include unpriced orders, Firm Fixed Priced (FFP) orders, and Cost Plus Profit (CPP) contracts. Any combination of these may be used on an NSN during its life cycle. Therefore, the prices stated are most often estimates of what a repair is expected to cost.

With the above in mind, it is now evident that little if any information can be derived from performing a regression analysis using pricing information from SPCC's data base. The negative correlation, however, was unexpected and a discussion with SPCC personnel showed this to be irregular. A positive correlation should always exist between the net pricing and the repair pricing for an item, since the repair pricing plus a surcharge is the basis for the net pricing. Further investigation, however, with SPCC pricing specialists led to the possible explanation of part of this negative trend due to the varying of the yearly surcharge charged to SPCC customers. In fact, the surcharge has fallen almost every year since 1985. The surcharges are listed in Table 10 below. It was also discovered for NSN 5845-00-450-1852 that the net pricing has been developed from both commercial and organic depot repair pricing. Further, the commercial depot used CPP, and the organic depot used FFP contracting. In fact, the only repair pricing variance which SPCC looks for is a variance between SPCC's most current historical repair price and the current net price. This once a year report is called the "Repair History File." [Ref. 17]

TABLE 10: YEARLY SURCHARGE RATES

Fiscal Year	Surcharge % Rate
1985	59%
1986	40%
1987	42%
1988	36.8%

One reason for the fall in the surcharge rates has been the improvement in the contracting techniques in the military. These newer methods have lessened the variance observed from year to year in the price paid for purchases of new material and for repairs to older material. Another cost which has decreased in the past few years is that of inflation. This has also helped reduce the cost of conducting business for the military.

Problems, however, still exist in the way business is currently conducted at SPCC. If current work conference pricing were used as the basis for the current net pricing, less impact would be felt by the Navy Stock Fund (NSF) when repair orders are placed by SPCC's item managers. There should also be review of the base replacement price when the old one is two or more years old. The following information is connected with the current pricing of NSN 4845-00-450-1852.

1. Current net pricing - $108
2. Historical repair price - two in 1986 from a commercial depot for $68 and $128
3. Current work conference repair pricing - $400 for repair at an organic repair depot as a FFP contract.
4. Current standard price - $323
5. Historical replacement pricing - $265 based on an order for 35 in 1985.
6. Current replacement cost estimate - $500 to $700 depending on the number ordered.

If this NSN were repaired today, a deficit of $292.00 would be charged to the NSF. If the same NSN was reordered, the NSF would also take a loss. Current pricing policy at SPCC does not allow charges to the fleet to reflect the current cost of repair or replacement. Instead, the surcharge is used as a buffer between what is really required and what is charged to fleet customers. A change to the pricing policy, therefore, would be most beneficial.

IV. LEVEL OF REPAIR ANALYSIS

A. BACKGROUND

Integrated Logistics Support (ILS) is part of every major system acquisition performed by the Navy today. The ultimate goal of the ILS is to make certain that proper support is available for a system when it is deployed. One of the main programs in this effort is the LSA. The LSA ensures that the overall program objectives are cost effective. The selection of the method for handling a new or already deployed system over its expected or remaining life is performed by the Level of Repair Analysis (LORA).

As stated in Chapter 2, a LORA is a trade-off analysis undertaken as part of the LSA to determine the least cost method of maintaining an item over its life cycle. This idea of developing a Life Cycle Cost (LCC) for an item is an important part in maximizing fleet readiness while ensuring that limited defense funding is spent in the most effective manner. LORAs are normally run on items when they first enter into service or when an interested party suspects that a change should be made in how an item is presently handled. The most important outcome of the LORA is the assignment of the SM&R codes. This SM&R code will guide the support chain's handling of the item over the items's Life Cycle (LC).

B. NAVSEA's LORA MODEL

The LORA models used today are basically of two types. The first uses a mathematical model and economic factors such as those listed in Table 11 to determine the least cost method of handling an item over its LC.

TABLE 11. BASIC COST CATEGORIES FOR ECONOMIC LEVEL OF REPAIR MODELS [Ref. 9:p. III-11]

A. Life Cycle
   1. Inventory
   2. Initial System Stock
   3. Allowance Quantity
   4. Replenishment
   5. Repair

B. Support Equipment

C. Training

D. Documentation

E. Transportation and Packaging

F. Space

G. Inventory Administration
   1. Holding
   2. Backorders
   3. Procurement Order
   4. Repair Management
   5. Item Entry
   6. Item Retention
   7. Repair Order

H. Field Supply Administration

I. Inflation/Discount

The second method of analysis uses non-economic factors to determine the best way to manage an item over its LC. Table 12 shows six exception criteria used by MIL-STD-1309B in deciding whether or not to categorize an item as a DLR.

The first four criteria are reasons to change an item from a NON-DLR to DLR, and the last two are reasons to change an item from a DLR to either a Consumable or a FLR.

TABLE 12. LORA EXCEPTION CRITERIA [Ref. 9:pp. III-9/10]

A. No Source of Procurement

B. Interservice Agreement

C. Maintaining Manufacturing Repair/Production for Mobilization

D. Deferred Support Decisions

E. No Identifiable Depot Overhaul Point (DOP) - Technical Skill Requirements

F. No Identifiable DOP - Structural Considerations

NAVSEA presently has two LORA computer models. The first of these models is the Level III analysis. The second is the VAX/PLI MOD V. Both models are used for LORAs, but the Level III model, which is the older of the two, is predominantly used for analysis of existing items, and is designed to run on a Texas Instrument (TI) programmable calculator. The MOD V model is much more complex. Its programing requires that it be run on a mainframe computer. The complexity of the output is different for both programs. The Level III offers one option at a time while the MOD V can list several different options in a single program run. For the purpose of the LORA for this paper, the Level III model was chosen. The Level III model will be

used to determine if the economic factors today show that the two NSNs should migrate from the DLR to NON-DLR management.

As mentioned earlier, there are two types of criteria used when performing a LORA. The Level III model uses economic "...factors of varying significance...to calculate the cost to the Navy of each LOR alternative." [Ref. 13:p. 1-3] Economic factors such as those listed in Table 11 above will be used by the Level III model to analyze the costs connected with continuing a particular management policy and the cost of changing to a new management policy. The output figures show the user what additional costs would be incurred by either changing or continuing an item's present maintenance classification. The LORA output does not include sunk costs and therefore should not be considered as a total LCC estimate. Instead, the LCC estimates should be viewed as incremental costs.

The items chosen for the LORA were the same two NSNs used for the regression analysis in Chapter III. This decision was made first because both items are presently coded as depot/depot level repairable even though they are listed in reference 10 as items capable of being screened by both the organizational and intermediate levels. The second reason for choosing these items is that one in particular, NSN 5845-00-450-1852, has a standard price of $323.00 and a repair price of $400.00. The above pricing

seems to support the possible categorization of that NSN as a FLR instead of a DLR. The final reason for choosing these two items is that both have proven to be repairable at the intermediate level.

C. LEVEL OF REPAIR ANALYSIS AND FINDINGS

In order to properly run a LORA, information must be gathered from many sources. The NAVSEA LORA LEVEL III USER's Manual [Ref. 13] makes many suggestions including:

1. Detailed drawings
2. One or more points of contact from the manufacturer
3. Technical manuals for the assembly
4. Table of shipping costs
5. One or more contacts on the Navy project office
6. A copy of Provisioning Technical Documentation (PTD)

Since this great preponderance of material was not directly available, information for the LORA was obtained from the item's manager, the program manager, the repair depot, the In-Service Engineering Activity (ISEA), and the Naval Material Transportation Office (NAVEMTO).

Tables 13 and 14 list the economic factors to be analyzed by the Level III LORA. The data is read in two parts with the centerline decimal point being the dividing point. Therefore, the first line of Table 13 would be read as "Total Equipment Population" 121, and "Installed Equipment Last Two Years" is also 121.

TABLE 13. LEVEL III LORA PROGRAM INPUTS
FOR NSN 5825-00-321-0671

REG	LEFT SIDE	DATA ENTRY	RIGHT SIDE
15	TOTAL EQUIP POP	121.0121	INSTALLED LAST 2 YRS
16	ASSEMBLIES/EQUIP	1.0025	1-WAY SHIPPING COST
17	PARTS/ASSEMBLY	1.0	NUMBER OF NEW NSNs
18	ANNUAL REPL RATE	12.99.	
19	ESSENTIALITY	1.0	ALLOWANCE O-RIDE QTY
20	REPLACEMENT PRICE	1920.0	DISCOUNT %
21	ORGANIZATIONAL SITES	121.0	O-LEVEL REPAIR RATE
22	INTERMEDIATE SITES	0.0	I-LEVEL REPAIR RATE
23	REPAIR DEPOTS	1.999	DEPOT SURVIVAL RATE
24	PRODUCTION LEAD TIME	104.92	CARCASS RETURN RATE
25	DEPOT REPAIR TAT WKS	12.0515	DEPOT REPAIR COST
26	PROGRAM LIFE YRS	20.0	MH FOR O/I REPAIRS
27	S&TE, O-LEVEL	0.0	% S&TE DED, O-LEVEL
28	S&TE, I-LEVEL	0.0	% S&TE DED, I-LEVEL
29	S&TE, D-LEVEL	55,700.0875	% S&TE DED, D-LEVEL

TABLE 14. LEVEL III LORA PROGRAM INPUTS
FOR NSN 5845-00-450-1852

REG	LEFT SIDE	DATA ENTRY	RIGHT SIDE
15	TOTAL EQUIP POP	721.0721	INSTALLED LAST 2 YRS
16	ASSEMBLIES/EQUIP	1.0025	1-WAY SHIPPING COST
17	PARTS/ASSEMBLY	1.0	NUMBER OF NEW NSNs
18	ANNUAL REPL RATE	13.88.	
19	ESSENTIALITY	1.0	ALLOWANCE O-RIDE QTY
20	REPLACEMENT PRICE	323.0	DISCOUNT %
21	ORGANIZATIONAL SITES	721.0	O-LEVEL REPAIR RATE
22	INTERMEDIATE SITES	0.0	I-LEVEL REPAIR RATE
23	REPAIR DEPOTS	1.85	DEPOT SURVIVAL RATE
24	PRODUCTION LEAD TIME	104.86	CARCASS RETURN RATE
25	DEPOT REPAIR TAT WKS	12.0400	DEPOT REPAIR COST
26	PROGRAM LIFE YRS	20.0	MH FOR O/I REPAIRS
27	S&TE, O-LEVEL	0.0	% S&TE DED, O-LEVEL
28	S&TE, I-LEVEL	0.0	% S&TE DED, I-LEVEL
29	S&TE, D-LEVEL	250,000.0633	% S&TE DED, D-LEVEL

For the purpose of this paper, the Level III analysis of DLR versus Non-DLR for existing items was chosen. The Level III model makes all required calculations for the cost comparison between the NON-DLR and DLR alternatives. Tables 15 and 16 on the following page list the results of the initial run though the Level III model.

TABLE 15. SUMMARY OF INITIAL OUTPUT STATISTICS
FOR NSN 5825-00-321-0671

	NON-DLR	DLR
Total Life Cycle Cost :	116,339,581.	40,292,439.
Item Entry, PTD, Repair Doc.:	208.	0.
Supply Management :	420,863.	1,262,053.
Allowance :	0.	0.
Initial System Stock :	4,905,600.	0.
Replenishment :	111,012,910.	8,983,164.
Repair, Shipping, S&TE :		30,047,222.

TABLE 16. SUMMARY OF INITIAL OUTPUT STATISTICS
FOR NSN 5845-00-450-1852

	NON-DLR	DLR
Total Life Cycle Cost :	125,736,034.	162,313,695.
Item Entry, PTD, Repair Doc.:	208.	0.
Supply Management :	2,648,902.	7,974,098.
Allowance :	0.	0.
Initial System Stock :	4,180,589.	0.
Replenishment :	118,906,335.	31,985,804.
Repair, Shipping, S&TE :		122,353,793.

The initial LORA results for NSN 5825-00-321-0671 show that it would cost an additional $40,292,439 to manage it as a DLR and an additional $116,339,581 for management as a NON-DLR. In such a case, the material should continue to be handled as a DLR. For NSN 5845-00-450-1852, additional costs of $162,313,695 and $125,736,034 would be incurred to handle the item as either a DLR or NON-DLR respectively. Since NSN 5845-00-450-1852 costs more to manage as a DLR than to reclassify the item as a NON-DLR, it appears that its management classification should be changed from DLR to NON-DLR. However, one should not take these results and immediately make a change in how an item is handled. The initial results should be subjected to sensitivity analysis

to determine how much of a change would be required to change the initial findings. Further, it is important to note where the main costs are for each of the two alternatives. The main cost for the NON-DLR alternative is the cost of replenishing the item over its LC and the additional cost of purchasing initial system stock. These costs are controlled by two main items, namely the availability of the material and the replacement cost over the system's expected life.

To discover how the LORA Model reacts to changes in the replacement cost for each NSN, several sensitivity analyses were performed on each NSN. A sensitivity analysis manipulates certain inputs from the original data while holding all other inputs constant in order to determine the effect on the original solution. The first of these sensitivity analyses are displayed in Tables 17 and 18 on the following page. The purpose of these first analyses is to see how changes in replacement price of an item affects the overall LCC of the NON-DLR and DLR alternatives.

TABLE 17. EFFECT OF ASSEMBLY COST ON LIFE CYCLE COST FOR NSN 5825-00-321-0671

ASSEMBLY COST	REPAIR AS A % OF COST	NON-DLR Added LCC	DLR Added LCC
$1,920.00	26.8%	$116,339,581.	$40,292,439.
$1,030.00	50.0%	$ 62,606,522.	$36,128,369.
$ 572.00	90.0%	$ 34,955,127.	$33,985,509.
$ 560.00	92.0%	$ 34,230,636.	$33,929,364.
$ 557.00	92.5%	$ 34,049,513.	$33,915,328.
$ 555.00	92.8%	$ 33,928,765.	$33,905,971.
$ 554.00	92.96%	$ 33,868,391.	$33,901,292.

TABLE 18. EFFECT OF ASSEMBLY COST ON LIFE CYCLE COST FOR NSN 5845-00-450-1852

ASSEMBLY COST	REPAIR AS A % OF COST	NON-DLR Added LCC	DLR Added LCC
$779.00	51.4%	$299,505,809.	$207,470,124.
$595.00	67.2%	$229,388,180.	$189,249,109.
$533.00	75.0%	$205,761,588.	$183,109,419.
$453.00	88.3%	$175,275,662.	$175,187,238.
$452.00	88.5%	$174,894,588.	$175,088,211.
$451.00	88.7%	$174,513,514.	$174,989,184.
$323.00	123.8%	$125,736,034.	$162,313,695.

As the cost of repair becomes a higher percentage of the total cost of replacing the assembly, the easier it is to make a decision to declare an item either a NON-DLR or a DLR. One can also note that although the above holds true for both items, the changeover occurs at different percentage amounts for the two items. This is mainly due to the differences in the cost of support and test equipment costs for repair of each item and its Depot Survival Rate (DSR). The DSR for an NSN is the percentage of items that is expected to survive the depot repair process. As can be noted from the input data, NSN 5825-00-321-0671 had a DSR of 99.99%, and NSN 5845-00-450-1852 had only a 85% DSR. To see how the DSR might affect the overall LCC of each NSN, sensitivity analyses were run for each NSN varying the DSR while keeping all remaining data inputs constant. The results are shown below in Tables 19 and 20. Note the difference in the way a change in the DSR affects the LCC of each NSN.

TABLE 19. DEPOT SURVIVAL RATE SENSITIVITY ANALYSIS
FOR NSN 5825-00-321-0671

Depot <u>Survival Rate</u>	NON-DLR <u>Added LCC</u>	DLR <u>Added LCC</u>
99.9%	$116,339,581.	$ 40,292,439.
90.0%	$115,853,821.	$ 47,559,760.
80.0%	$115,362,301.	$ 54,900,489.
70.0%	$114,870,781.	$ 62,241,218.
50.0%	$113,889,661.	$ 76,922,675.
30.0%	$112,906,621.	$ 91,604,133.
0.0%	$111,433,981.	$112,343,968.

TABLE 20. DEPOT SURVIVAL RATE SENSITIVITY ANALYSIS
FOR NSN 5845-00-450-1852

Depot <u>Survival Rate</u>	NON-DLR <u>Added LCC</u>	DLR <u>Added LCC</u>
99.9%	$126,468,921.	$167,125,271.
90.0%	$125,981,837.	$163,928,317.
80.0%	$125,490,231.	$160,699,072.
70.0%	$124,998,302.	$157,469,826.
50.0%	$124,014,767.	$151,011,334.
30.0%	$123,030,909.	$144,552,843.
0.0%	$121,555,445.	$127,261,179.

For NSN 5825-00-321-0671, the sensitivity analyses results for changes in the DSR show an increase in the cost of the DLR alternative, while the cost of the NON-DLR alternative decreased. For NSN 5845-00-450-1852, the effect was just the opposite for the DLR alternative. This occurrence can be explained by the differences in the cost to replace and repair each NSN. For the first NSN, it is less expensive to repair than to replace. Therefore, as the DSR decreases and more items are required to be replaced at the depot level, a larger system inventory must be carried. This in turn results in a requirement to purchase less initial stock

when considering a switch to the NON-DLR alternative, thus reducing the cost of the NON-DLR alternative. Conversely, the second NSN shows opposite results for the DLR alternative. This is because its replacement price is cheaper than its repair price. As the DSR falls and more items fail depot repair, it is less costly to replace them. This reduces the cost of the DLR alternative. As with the first NSN, however, the decrease in cost for the NON-DLR alternative is due to the reduced need for added initial stock. This is a result of the increased need for system stock at the depot because of the lower DSR.

Another variable which affects the LCC of an item is its annual replacement rate. The annual replacement rate used for the LORA was the average demand per year as carried by SPCC's data base. The LCC is not as sensitive to a change in the annual replacement rate as it was for the replacement price of the item. This is because the replacement rate only affects the number of items which will need to be procured over the LC of the item and not the cost of these items. Therefore, although the total cost is dropping, the cost difference between the item's replacement cost and its repair cost is still the main driving force for the LCC until demand becomes extremely small. At this point, the inherent cost to repair takes over and make the repair option more expensive. The results are shown below in Tables 21 and in Table 22.

TABLE 21. EFFECT OF ANNUAL REPLACEMENT RATE ON LIFE CYCLE COST FOR NSN 5825-00-321-0671

REPLACEMENT RATE	NON-DLR Added LCC	DLR Added LCC
12.99	$116,339,581.	$40,292,439.
6.	$ 53,741.372.	$18,628,549.
1.	$ 8,960,236.	$ 3,132,204.
0.5	$ 4,483,083.	$ 1,582,571.
0.05	$ 454,028.	$ 183,855.
0.005	$ 47,605.	$ 38,424.

TABLE 22. EFFECT OF ANNUAL REPLACEMENT RATE ON LIFE CYCLE COST FOR NSN 5845-00-450-1852

REPLACEMENT RATE	NON-DLR Added LCC	DLR Added LCC
13.88	$125,736,034.	$162,313,695.
10.00	$ 90,589,601.	$116,963,423.
5.00	$ 45,297,604.	$ 58,522,350.
2.00	$ 18,122,663.	$ 23,457,707.
1.00	$ 9,064,134.	$ 11,769,492.

It is important to investigate the cost of Procurement Leadtime (PLT) and Repair Turnaround Time (RTAT) on an item's LCC. Tables 23 and 24 display the results of the PLT sensitivity analyses, and Tables 25 and 26 display the results of the RTAT sensitivity analyses.

TABLE 23. EFFECT OF PLT ON LIFE CYCLE COST FOR NSN 5825-00-321-0671

PLT	NON-DLR Added LCC	DLR Added LCC
26 WKS	$112,180,861.	$40,292,439.
44 WKS	$113,140,861.	$40,292,439.
52 WKS	$113,569,021.	$40,292,439.
80 WKS	$115,060,861.	$40,292,439.
104 WKS	$116,339,581.	$40,292,439.
156 WKS	$119,113,981.	$40,292,439.

TABLE 24. EFFECT OF PLT ON LIFE CYCLE COST
FOR NSN 5845-00-450-1852

PLT	NON-DLR Added LCC	DLR Added LCC
26 WKS	$122,191,432.	$162,313,695.
44 WKS	$123,009,591.	$162,313,695.
52 WKS	$123,372,966.	$162,313,695.
80 WKS	$124,645,586.	$162,313,695.
104 WKS	$125,736,034.	$162,313,695.
156 WKS	$128,098,779.	$162,313,695.

TABLE 25. EFFECT OF RTAT ON LIFE CYCLE COST
FOR NSN 5825-00-321-0671

RTAT	NON-DLR Added LCC	DLR Added LCC
5 WKS	$116,713,981.	$40,292,439.
10 WKS	$116,447,101.	$40,292,439.
12 WKS	$116,339,581.	$40,292,439.
20 WKS	$115,913,341.	$40,292,439.
30 WKS	$115,379,581.	$40,292,439.

TABLE 26. EFFECT OF RTAT ON LIFE CYCLE COST
FOR NSN 5845-00-450-1852

RTAT	NON-DLR Added LCC	DLR Added LCC
5 WKS	$126,054,189.	$162,313,695.
10 WKS	$125,826,797.	$162,313,695.
12 WKS	$125,736,034.	$162,313,695.
20 WKS	$125,372,659.	$162,313,695.
30 WKS	$124,918,198.	$162,313,695.

In both sets of analyses, only the NON-DLR alternative's cost was affected. This results because the Level III model only displays the incremental cost of the change between the two alternatives and not the total cost of the change. Both PLT and RTAT changes affect only the quantity of initial system stock required for a change to the NON-DLR alternative. As PLT is increased, the additional system

stock held for the DLR alternative is considered a sunk cost by the model and only the added cost of additional system stock for the NON-DLR alternative is reflected. Conversely, a change in the RTAT has the opposite effect on the two NSNs. A decrease in RTAT results in less system stock being held for the DLR alternative, thereby increasing the number of initial system spares required to be purchased in order to switch to the NON-DLR alternative. An increase in RTAT results in an increased need for pipeline inventory which reduces the number of initial system spares required for a switch to the NON-DLR alternative.

Both of the NSNs dealt with here require SM&R changes to reflect that they are in fact progressive level DLRs. The LORA results, however, show that NSN 5825-00-321-0671 should remain presently as a DLR. NSN 5845-00-450-1852, however, requires additional research before it is moved from the ranks of DLRs to FLRs. The additional questions needing to be addressed are:

1. What is the current replacement price for the item?
2. Is the item still available for procurement?
3. Do the IMAs have full screening and fault isolation capability on this NSN?

These questions must be answered before any change can be suggested to the Hardware Systems Command (HSC). The LORA only suggests items worthy of additional research.

V. 3-M AND ENSURING REQUIREMENT JUSTIFICATION

A. BACKGROUND

Ship's Maintenance and Material Management (3-M) system began in 1965, the year after the Aviation 3-M system was implemented. Both 3-M systems are part of the overall Integrated Logistics Support System (ILSS) which has been installed by the Navy as "...a management tool designed to provide efficient, uniform methods of conducting and recording preventative and corrective maintenance in a way that allows fast and easy access to the collected data." [Ref. 14:p. 2-2]

Two main subsystems of the 3-M system are the Planned Maintenance System (PMS) and Maintenance Data System (MDS). PMS is "...concerned with preventive maintenance, and MDS is concerned with the collection of corrective maintenance and configuration data." [Ref. 14:p. 2-2]

MDS is of significant importance to the Navy's ILSS. MDS is the primary method whereby all data concerning corrective maintenance and configuration changes are collected into a computerized data base for the purposes of analysis, maintenance and configuration tracking, and maintenance forecasting. All 3-M data is passed either directly or indirectly to the Fleet Analysis Center (FLTAC) located in Mechanicsburg, Pennsylvania. The FLTAC, also

known as the Navy Maintenance Support Office (NAMSO), has recently been reorganized and absorbed by the Naval Sea Logistics Center (NAVSEALOGCEN) which acts as SPCC's In-service Engineering Activity (ISEA), and is the repository for all shipboard 3-M data.

SPCC is faced with certain problems when using the information available from NAVSEALOGCEN. Presently, there are two very different types of 3-M data being collected by the Navy's 3-M system. Part of the information comes in the form of 3-M procurement documentation for ships performing both preventive and repair maintenance on shipboard systems. The second involves pure maintenance data pertaining to repairs performed without need for the requisitioning of a repairable end item. The main problem for SPCC comes from the fact that only 3-M procurement information can provide the piece/part information required to forecast future demand and procurement quantities accurately. This piece/part information comes in the form of NSNs, circuit symbol numbers, or manufacturer's part numbers. Conversely, pure maintenance data provides only equipment data and no piece/part information. This information is used by the ISEA for keeping track of system configuration and maintenance factors for systems as a whole, but provides nothing from which SPCC's present inventory models can predict usage demand. However, not all SPCC procurement actions are affected by present 3-M

documentation. The present methods work well for SPCC's present consumable and FLR models as both are considered expended by SPCC when issued. However, DLRs provide SPCC with a completely different set of problems. In order to manage DLRs, SPCC must be able to accurately know demand, Repair Survival Rates (RSR), Procurement Leadtime (PLT), and RTAT for DLRs. For DLRs which are managed completely from the depot level, there is no problem with collecting the above information. For DLRs which are handled as progressive repairables, however, SPCC is unable to collect accurate procurement information. This problem is due to SPCC's inability to use 3-M maintenance documentation for anything other than overall system status. The loss of this information can adversely affect the quantity stocked of an item by SPCC. This occurs because 3-M procurement data is exchanged for 3-M maintenance data which is unable to provide the required piece/part information concerning a maintenance action.

As STEEP has gained momentum and more ATEs have been added to the fleet, the number of NSNs coded as progressive DLRs has steadily risen. Today approximately 88 percent of all DLRs are SM&R coded as progressive DLRs. The loss of procurement information to SPCC is at present negligible. This, however, is due mainly because many items are now being forwarded to repair depots prior to exhausting the NSN's progressive options of organizational and

intermediate level screenings and repairs. The present problem of NEOF points to this. However, as the Fleet CINCs' resolve to end this problem increases, more 3-M procurement data will be lost to SPCC's inventory data base. At the same time, additional information concerning 3-M maintenance actions from both the organizational and intermediate levels will be provided to a system unable to use it.

The problem for SPCC is finding a way of overcoming the loss of its procurement information on material which is categorized as a progressive DLR. The easiest solution to this problem would be for SPCC to use the 3-M data currently available for all maintenance actions performed on a system. Unfortunately, present shipboard 3-M maintenance documentation is tied strictly to equipment nomenclature and rarely, if ever, lists piece/part information. Therefore, the data available to SPCC is of no value since its data base uses only historical NSN procurement demands to forecast future demand. This is exemplified in a case in which a circuit card in system A fails, and the circuit card has a 7HH COG and MCC. There are presently two options for the handling of this item. Both options require the knowledge of the item's SM&R coding. In one case, the item is coded as a fourth and fifth digit SM&R coding of DD. This item is a plain DLR and is to be immediately procured when a failure is noted.

No repair is authorized below the depot level. Therefore, no effect on SPCC's data base for usage is noted. In another case, the item has the same COG and MCC of 7HH, but the fourth and fifth positions of its SM&R code are now GD. In such cases, the item is known as a progressive DLR, and depending on abilities at the organizational and intermediate levels, both screening and repairs are possible. If repairs are made either by the shipboard repair technician or the IMA, only 3-M maintenance documentation will be available, and SPCC will lose demand/failure information on this item. The loss of such information will appear as a reduction in the demand for this item, but in fact the demand still exists. Only the documentation has changed. If enough such cases occurred, an item could see its inventory levels reduced as SPCC's computer based model adjusts itself for the loss of procurement information on an item.

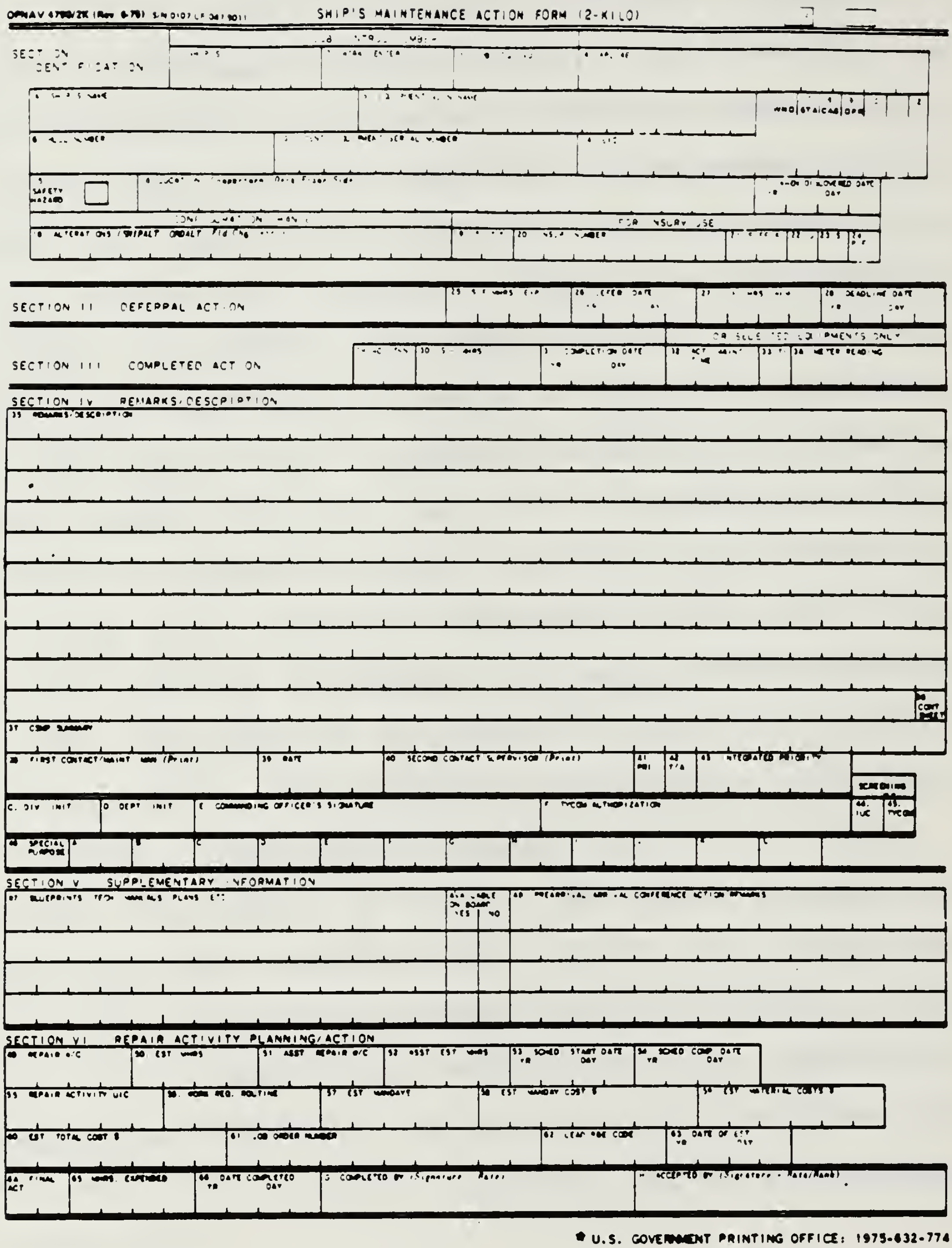
In the above two cases, 3-M documentation was available, but only the procurement format provided the piece/part information required by SPCC's data base. If the maintenance documentation carried piece/part information, SPCC would be able to draw this information from the MDS data base and substitute it for the lost procurement documentation.

The present Shipboard Maintenance Action Form OPNAV 4790/2K is displayed in Figure 3 on page 48. Note that the

identifying information section only requires system information and not any piece/part information.

Conversely, in the aviation community, the main maintenance action form is the Visual Information Display System/Maintenance Action Form (VIDS/MAF) shown in Figure 4 on page 49. The VIDS/MAF "...is used by supported maintenance and supply activities to request work or assistance from the supporting IMA that is beyond the requesting activity's capability and does not involve repair of aeronautical equipment." [Ref. 15:p. 6-36] Note that in blocks 14, 19 and 34 of the Failed/Required material section of the VIDS/MAF, piece/part information and not system information is used. This allows the aviation MDS access to information relating to parts failure and repair rates at the organizational level and gives ASO a clearer picture of end user requirements.

The Work Request Customer Service OPNAV 4790/36A, shown in Figure 5 on page 50, is used by the IMA when requesting assistance from depots "...to complete components delayed due to lack of facilities for check and test, or for processing not normally required..." [Ref. 16:p. 8-23] or performed at the IMA. Note that on this form piece/part information is also included.



OPNAV 4790/2K (Rev 6-79) S/N 0107-LF-047-9011 SHIP'S MAINTENANCE ACTION FORM (2-KILO)

SECTION I IDENTIFICATION

SAFETY HAZARD

SECTION II DEFERRAL ACTION

SECTION III COMPLETED ACTION

SECTION IV REMARKS/DESCRIPTION

37 CSMP SUMMARY

38 FIRST CONTACT/MAINT MAN (Print) | 39 DATE | 40 SECOND CONTACT SUPERVISOR (Print) | 41 PRI | 42 T/A | 43 INTEGRATED PRIORITY

SCREENING

C. DIV INIT | D DEPT INIT | E COMMANDING OFFICER'S SIGNATURE | F TYCOM AUTHORIZATION | 44. IUC | 45. TYCOM

46 SPECIAL PURPOSE

SECTION V SUPPLEMENTARY INFORMATION

47 BLUEPRINTS TECH MANUALS PLANS ETC | AVAILABLE ON BOARD YES NO | 48 PREARRIVAL ARRIVAL CONFERENCE ACTION REMARKS

SECTION VI REPAIR ACTIVITY PLANNING/ACTION

49 REPAIR W/C | 50 EST MHRS | 51 ASST REPAIR W/C | 52 ASST EST MHRS | 53 SCHED START DATE YR DAY | 54 SCHED COMP DATE YR DAY

55 REPAIR ACTIVITY UIC | 56 WORK REQ. ROUTINE | 57 EST MANDAYS | 58 EST MANDAY COST $ | 59 EST MATERIAL COSTS $

60 EST TOTAL COST $ | 61 JOB ORDER NUMBER | 62 LEAD RCC CODE | 63 DATE OF EST YR DAY

64 FINAL ACT | 65 MHRS. EXPENDED | 66 DATE COMPLETED YR DAY | G COMPLETED BY (Signature Rate) | H ACCEPTED BY (Signature - Rate/Rank)

U.S. GOVERNMENT PRINTING OFFICE: 1975-632-774

Figure 3: Ship's Maintenance Action Form [Ref. 14:p. 3-4]

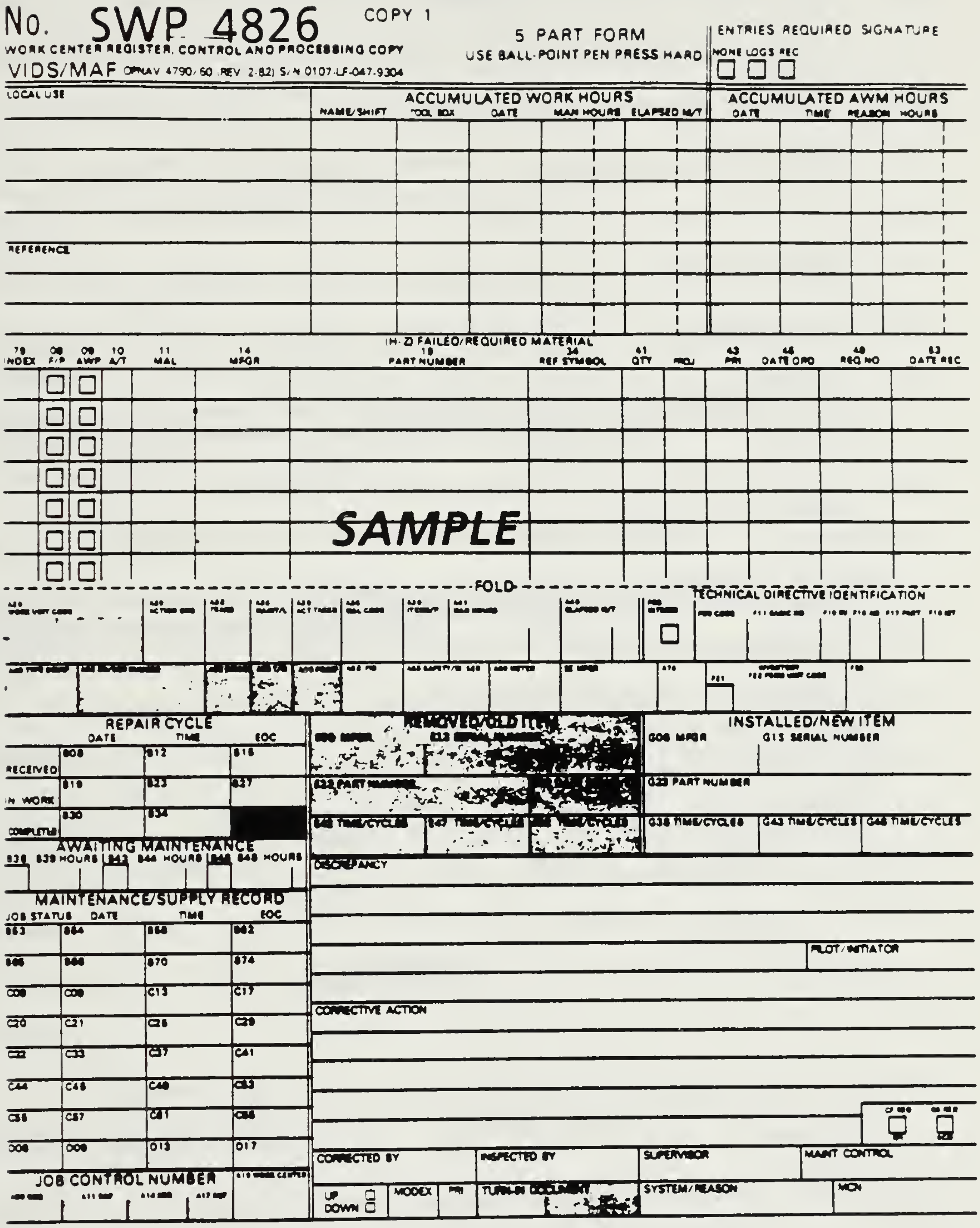


Figure 4: VIDS/MAF (OPNAV 4790/60) [Ref. 15:p. 11-19]

WORK REQUEST CUSTOMER SERVICE
OPNAV 4790/36A (REV. 10-74) S/N 0107-LF-047-9180

PART I TO BE COMPLETED BY IMA (INTERMEDIATE MAINTENANCE ACTIVITY)

1 DATE	2 JCN		3 ISSUE DOCUMENT NUMBER
4 PART NUMBER	5 PART SERIAL NUMBER	6 MANUFACTURE CODE	7 NOMENCLATURE
8 NATIONAL STOCK NUMBER	9 QUANTITY	10 TYPE AIRCRAFT EQUIPMENT	11 BU SER NUMBER

12 CATEGORY (Amplify on back of form)

☐ NORS ☐ NFE ☐ WORK STOPPAGE ☐ OTHER

13 WORK REQUESTED JUSTIFICATION FOR WORK REQUESTED (Attach amplifying instructions if required)

14 CERTIFICATION I CERTIFY THAT THIS WORK IS BEYOND THE CAPABILITY OF IMA
SIGNATURE | DATE

15 FOR FURTHER INFORMATION CONTACT (Activity and telephone number)	16 REQUIRED COMPLETION DATE	AUTHORIZED BY

PART II TO BE COMPLETED BY SSC (SUPPLY SUPPORT CENTER)

18

☐ LOCAL AREA AVAILABILITY CHECKED ☐ SUPPLY AVAILABILITY CHECKED ☐ REQUIREMENT SATISFIED FROM ABOVE SOURCES ☐ REQUIREMENT FORWARDED TO NARF FOR ACTION

SIGNATURE | DATE

18 CERTIFICATION APPROVAL I CERTIFY THAT THIS REQUIREMENT CANNOT BE SATISFIED FROM OTHER SOURCES
SIGNATURE | DATE

PART III TO BE COMPLETED BY NARF (NAVAL AIR REWORK FACILITY)

20 RECEIVED BY	20a DATE	20b PCN/WORK ORDER	20c PRIORITY	20d DATE WORK STARTED

21 ACTION TAKEN

22a COMPLETED BY	22b DATE	22c INSPECTED BY	22d. SUPERVISOR	22e MAN HOURS	22f EMT

23 SUPPORTED ACTIVITY NOTIFIED BY	THAT WORK HAS BEEN COMPLETED PERSON NOTIFIED	DATE	TIME	CHARGE TO FAN

24 DISPOSITION

☐ WORK COMPLETED ☐ F/U UNIT PROVIDED ☐ SUPPORTED ACTIVITY NOTIFIED TO ORDER FROM SUPPLY (Explain in Remarks)

25 RECEIVED FROM SUPPORTING ACTIVITY BY | DATE | TIME

26 REMARKS

SAMPLE

27 ☐ APPROVED ☐ DISAPPROVED	27a REASON (If work disapproved)	27b SIGNATURE (Supporting Activity)

Figure 5: Work Request Customer Service (OPNAV 4790/36A) [Ref. 15:p. 6-37]

B. USES OF 3-M DOCUMENTATION

If the OPNAV 4790/2K were to be changed so that piece/part information could be used along with system information, SPCC's data base dealing with parts, usage would be significantly enhanced. Ships with ATEs would be required to forward a copy of the ATE's readout along with the 2-Kilo repair document to the IMA. If repairs were accomplished at the IMA, the PCB would be returned to the command and the completed 3-M action would find its way into SPCC's MDS files at NAVSEALOGCEN.

In cases where the IMA could not repair the DLR, the carcass would be returned to the command for turn-in through the normal channels. However, the 2-kilo document accompanying the carcass would now reflect screening by the IMA prior to it being forwarded to the depot for repairs or condemnation. In the case of a FLR, the IMA would condemn the item if not repairable and inform the command to reorder the part through normal supply channels. In both cases, OPTAR funding would be saved because of the screening of the material prior to turn-in, disposal, or reorder.

In a system such as above, the 3-M system would not be changed significantly at the field level. Instead, the majority of the changes would be felt at the ICP level where there would be information available from NAVSEALOGCEN's MDS data base concerning piece/part failure

and repair rates from the field and intermediate levels. Such a file could be queried to supply the numbers of NSNs repaired by IMAs. Just as today, shipboard repair actions could be tracked in the form of the Job Control Numbers (JCNs) and these same JCNs would be included as part of the parts requisitioning process. This would allow SPCC to exclude those repairs which ended in condemnations and were finally requisitioned.

Changing the shipboard 3-M system to reflect piece/part information makes dollar sense today. The changes required are few, but the added tracking ability would allow SPCC to manage its inventory of DLRs and FLRs more closely. The use of 3-M documentation could also help reduce inventory quantities held by SPCC as safety stock by increasing the data base used for forecasting demand on repairables.

VI. RECOMMENDATIONS AND CONCLUSION

A. GENERAL COMMENTS

This thesis has covered some of the areas which could help the Navy save operational funding while still keeping its operational availability goals intact. As the Defense Department's budget is reduced further in upcoming years and the Navy's share decreases, the operational CINCs will find it increasingly hard to accomplish their missions with less Operation and Maintenance Navy (O&MN) money to spend each year. The apparent loss of operational funding due to NEOF will force the CINCs to allow their repair technicians to try to repair all items at the organizational and intermediate levels. This will result in more problems than solutions. Repair technicians do not have the equipment and training to repair all items presently deployed in the fleet, but they do have more ability than what is currently being credited to them. Although no one solution is all encompassing, a good starting point would be to stop the syphoning off of the CINCs' O&MN dollars to the Navy Stock Fund (NSF) by NEOF among DLRs and FLRs.

B. RECOMMENDATIONS

In order to stop this flow of funding and correct the problem of NEOF among repairables, several steps must be

taken. The following is a list of five actions which, if correctly implemented, would correct the problem of NEOF among repairables as well as save O&MN funding for the operational CINCs.

1. Stock Number Groupings

Presently NSNs are grouped into three main categories. These groupings include consumables, FLRs and DLRs. The first recommendation concerns the segregation of all stock numbers into five areas according to their SM&R coding. The first of these areas would be pure depot level repairables. This group should include all items coded for no repair authorized below the depot level according to their SM&R coding. The second grouping would be progressive repairables. This group should have new COGs assigned. Possibly a 5H or 5G COG would be a good choice. The third grouping would be progressive FLRs. At present, only 89 items have been listed as 3H COG material by SPCC. As mentioned in chapter three, there are presently over 89,000 items SM&R coded as progressive FLRs. SPCC is presently trying to have the HSCs reverify SM&R coding prior to any COG reassignment. What should occur is the immediate COG migration for all items presently SM&R coded as a progressive FLR. This action could be followed by a reverification of those items suspected of being SM&R coded in error. The reason for this is that each day that these items do not have their COGs changed, money will be wasted

because of improper handling of these items. The fourth grouping would be 1HD FLRs which will actually become organizational level repairables. Although theses FLRs will have condemnation authority at the organizational level, many of these items could still be repaired by IMAs when the shipboard technician is unable to make corrections. Therefore, care must be taken in the writing of disposition instructions for all FLRs. The fifth and final grouping would be pure consumable items.

2. ATE and 2M Deployment

The second recommendation involves the present deployment of ATEs and 2M capability to the fleet. At present, 2M stations are granted prior to ATEs because of cost. It is also not mandatory at this time for a ship to have personnel assigned with any of the four 2M repair NECs. Consequently, a ship which has the more expensive ATE may or may not have someone onboard who carries the proper NEC to handle the equipment. One recommendation would be that the ships which are on the list to receive ATEs or 2M stations or who already have one or the other should have 2M NECs added to their list of required NECs. Further, attention should be paid to the importance of having all senior repair technicians for all ships trained in 2M capability as they will eventually be transferred, and their training can be utilized elsewhere.

3. Which Items to Screen

A third recommendation concerns determining on which pieces of equipment should money be spent to obtain either screening or fault isolation TPSs capability. Realizing that money is a scarce resource, every dollar spent on repair capability must be maximized. In purchasing screening or fault isolation capability, three concerns should be taken into account. The first is the demand for the item. If the item only fails once or twice a year, it may be less costly to stock a spare and repair the item at the IMA or depot level. The LORA can help determine this through a simple cost analysis. The second concern is the complexity of the item. If the item is very complex, the cost for the TPS will be more expensive. Another concern is if the repair capability of the personnel is adequate at the fleet level. This decision should be made by the HSC as part of the LSA during the equipment's prototyping and designing phases. The final aspect concerns whether or not the item should be a repairable. This, too, can be handled by the LORA. This cost analysis will determine if an item is worth repairing. It is important that the LORA is not just a one time exercise. It should be calculated every few years or whenever technology has made it economically possible to repair an item at a lower level.

4. Parts Availability

One recurrent problem concerns the availability of repair parts for repairables. It seems that although standardization policies have been enacted, systems are being brought on-line with modifications which make them nonstandard in nature. These changes are made in the name of cost savings and deadline meeting, but if the true cost of carrying these new lines of repair parts was considered, it would soon be apparent that nonstandard equipment is not cost effective in the long run. One panacea in this concern is that the Program Manager (PM) not be allowed to make changes to system design when these changes involve nonstandard equipment substitutions. These decisions should be made by the HSC which is more concerned with the entire LC of the system and not just the deployment of a system ahead of schedule and under cost.

5. Uses of 3-M Documentation

The final recommendation concerns the present 3-M capability for surface forces. It is recommended that changes be implemented that would add piece/part information to SPCC's MDS data base. The information available on failure and repairs at the organizational and intermediate levels would help SPCC better forecast demand for progressive field level and depot level repairables. The cost savings would come in the form of possible inventory reductions and even more so in the form of

increased Ao. As SPCC does a better job of carrying the material requested by the fleet in the correct amounts, less shortages will be noted and repairs will be made without the dreaded awaiting parts syndrome.

C. CONCLUSION

All activities in the Navy must do their part in order for any savings to be made. Partial or slow implementation by any one activity only adds to the waste, and it costs additional dollars. One final item that must be stressed is that training must also be accomplished. This training must reach not only the supply personnel but the repair technicians as well.

In summary, if all activities in the Navy do their part in correcting the NEOF problem, operational funding can be saved for its intended use of repairing downed equipment. The funding saved and the decreased repairable RTAT will allow the operational CINCs to further enhance their Ao and repair additional downed systems without additional funding. These repaired systems may be what is required in time of need to save lives.

APPENDIX A: ACRONYMS AND MEANINGS

ATAC	Advance Tracking and Control
ATE	Automatic Testing Equipment
BOA	Basic Ordering Agreement
CASREP	Casualty Report
CINC	Commander in Chief
COG	Cognizance
COMNAVAIRLANT	Commander Naval Aviation Forces Atlantic Fleet
COSAL	Coordinated Shipboard Allowance List
DLR	Depot Level Repairable
DOP	Depot Overhaul Point
DSR	Depot Survival Rate
EM	Electronic Module
FLR	Field Level Repairable
HSC	Hardware Systems Command
ICP	Inventory Control Point
ILSP	Integrated Logistics Support Plan
ILS	Integrated Logistics Support
ILSS	Integrated Logistics Support System
IM	Inventory Managers
ISEA	In-service Engineering Activity
JCN	Job Control Number
LCC	Life Cycle Cost
LM	Logistics Manager
LSA	Logistics Support Analysis

LORA	Level Of Repair Analysis
MCC	Material Condition Code
MDS	Maintenance Data System
NAMSO	Navy Maintenance Support Office
NAVELEX	Naval Electronics Systems Command
NAVSEA	Naval Sea Systems Command
NAVSEACOMBAT-SYSENGSTA	Naval Sea Combat Systems Engineering Station
NAVSUP	Naval Supply Systems Command
NEC	Naval Enlisted Classification
NEOF	No Evidence Of Failure
NFE	No Failure Evident
NSF	Navy Stock Fund
NSN	National Stock Number
O&MN	Operation & Maintenance Navy
OPTAR	Operating Target
PCB	Printed Circuit Board
PLT	Procurement Leadtime
PM	Program Manager
PMO	Program Management Office
PMS	Planned Maintenance System
PSP	Portable Service Processor
RCM	Reliability Centered Maintenance
RFI	Ready For Issue
RSR	Repair Survival Rate
RTAT	Repair Turnaround Time
SIMA	Shore Intermediate Maintenance Activity

SPCC	Ship's Parts Control Center
SM&R	Source, Maintenance, and Recoverability
STEEP	Support & Test Equipment Engineering Program
TPS	Test Program Sets
2M	Miniature/Microminiature
3-M	Maintenance and Material Management

APPENDIX B: THIRD POSITION MAINTENANCE CODES [Ref. 9:pp. III-21/22]

Code	Definition
D	Support items that are removed, replaced, and used at depots only.
F	Support items that are removed, replaced, and used at the intermediate level afloat.
G	Support items that are removed, replaced, and used at both the afloat and ashore intermediate levels.
H	Support items that are removed, replaced, and used at the intermediate levels ashore only.
L	(Restricted to SSPO only.)
O	Support items that are removed, replaced, and used at the organizational level of maintenance.

Note: To distinguish between the organizational maintenance capabilities on different classes of ships the following codes may be used (intra-Navy only). On joint programs, Navy will receive and transmit an "O" to indicate organizational maintenance level.

2	Minesweeper, Yardcraft, Patrol Boat.
3	Submarines.
4	Auxiliary/Amphibious Ships.
5	Major Combatants (Destroyers, Frigates).
6	Major Combatants (Cruisers, Carriers, LHAs-Amphibious Assault Ships).
7	Organizational shore activity only; not authorized for removal/replacement afloat.

S	Support items that are removed, replaced, and used at designated intermediate level specialized repair activities only. Removal is not authorized below intermediate level.
Z	Support items that are not authorized to be removed or replaced at any level.

APPENDIX C: FOURTH POSITION MAINTENANCE CODES [Ref. 9:pp. III-22/24]

Code	Definition
B	Support item for which no repair is authorized.
D	Support item for which the depot level is the lowest level of maintenance authorized by the maintenance plan to return the item to serviceable condition from any failure mode.
F	Support items for which the intermediate level afloat (only) is the lowest level of maintenance authorized by the maintenance plan to return the item to serviceable conditions from some but not necessarily all, failure modes.
G	Support items for which the intermediate level either afloat or ashore is the lowest level of maintenance authorized by the maintenance plan to return the item to serviceable condition from some but not necessarily all, failure modes.
H	Support item for which intermediate level ashore only is the lowest level of maintenance authorized by the maintenance plan to return the item to serviceable condition from some, but not necessarily all, failure modes.
L	(Restricted to SSPO use only.)
O	Support items for which the organizational level is the lowest level of maintenance authorized by the maintenance plan to return the item to serviceable condition from some but not necessarily all, failure modes.

Note: To distinguish between the organizational maintenance capabilities on different classes of ships, the following codes may be used (intra-Navy only). On joint programs, Navy will receive and transmit an "O" to indicate organizational maintenance level.

2	Minesweeper, Yardcraft, Patrol Boat.
3	Submarines.
4	Auxiliary/Amphibious Ships.
5	Major Combatants (Destroyers, Frigates).
6	Major Combatants (Cruisers, Carriers, LHAs-Amphibious Assault Ships).
7	Organizational shore activity only; not authorized for repair afloat.
S	Support item for which a special intermediate repair activity is the lowest level of maintenance authorized by the maintenance plan to return the item to serviceable condition from some, but not necessarily all, failure modes.
Z	A nonrepairable support item. No repair is authorized.

APPENDIX D: RECOVERABILITY CODES [Ref. 9:pp. III-25/26]

Code	Definition
A	Nonrepairable item; requires special handling or condemnation procedures because of specific reasons (i.e., precious metal content, high dollar value, critical material, or hazardous material).
D	Repairable item. Indicates the lowest maintenance level authorized by the maintenance plan to return the item to serviceable condition from all failure modes. The level authorized to direct disposition of an unserviceable item is the depot level.
F	Repairable item. Indicates the lowest maintenance level authorized by the maintenance plan to return the item to serviceable condition from all failure modes. The level authorized to direct disposition of the unserviceable item is the intermediate level afloat.
G	Repairable item. Indicates the lowest maintenance level authorized by the maintenance plan to return the item to serviceable condition from all failure modes. The level authorized to direct disposition of an unserviceable item is the intermediate level, either afloat or ashore.
H	Repairable item. Indicates the lowest maintenance level authorized by the maintenance plan to return the item to serviceable condition from all failure modes. The level authorized to direct disposition of an unserviceable item is the intermediate level ashore.
L	(SSPO use only.)
O	Repairable item. Indicates the lowest maintenance level authorized by the maintenance plan to return the item to serviceable condition from all failure modes. The level authorized to direct disposition of an unserviceable item is the organizational level.

S Repairable item. Return to Special Intermediate Repair Activity. Condemnation and disposal not authorized below special intermediate level.

W Repairable item. Item can be restored from all possible failure modes by the organizational level but must be returned to the depot level for condemnation and disposal.

Y Repairable item. Item can be restored from all possible failure modes by the intermediate level but must be returned to the depot level for condemnation and disposal.

Z Nonrepairable item. When unserviceable, condemn and dispose of at the level indicated in position 3 of the uniform SM&R code format.

APPENDIX E: COMMONLY USED MCCs [Ref. 9:p. III-27]

Code	Definition
D	Field Level Repairable.
E	(1) IRAM program; (2) Material requiring lot and serial number control.
G	FBM weapon system repairables.
H	Depot level repairables.
L	Local stock items or items awaiting NSN assignment.
Q	FBM weapon system repairables requiring special test, special report, or periodic inspection.
W	Ground support equipment end item.
X	Special program repairables.

APPENDIX F: NSN INFO BY EQUIPMENT TYPE

The information listed below pertained to the ten NSNs which were tested by SIMA San Diego during one or both its two test for NEOF rates on repairables during calendar year 1987. Each subdivision lists the pertinent information concerning the NSN such as its COG, MCC, SM&R, net price, commercial repair price, depot repair price, discovered NEOF rate, and whether it is listed as a DLR or a progressive DLR. There is also information concerning the numbers of each NSN which were either requisitioned or repaired each FY.

<u>AIMS MK XII IFF DECODER :</u>

			NET		COMMERCIAL		ORGANIC
NSN: 5895-00-395-0292	FY	QTY	PRICE	QTY	DEPOT	QTY	DEPOT
COG & MCC 7EH	84	32	$676.00				
SM&R PA2GD	85	51	$719.00	91	$298.00	70	$452.00
NEOF RATE 50.00%	86	133	$699.00			60	$499.00
1 of 2	86					30	$449.00
Progressive Repairables	87	153	$709.00	100	$298.00	140	$404.00
	88	15	$354.00				

			NET		COMMERCIAL		ORGANIC
NSN: 5895-00-395-0295	FY	QTY	PRICE	QTY	DEPOT	QTY	DEPOT
COG & MCC 7EH	83			39	$628.00		
SM&R PA2GD	84	18	$289.00				
NEOF RATE 46.00%	85	24	$303.00				
6 of 13	86	62	$301.00			78	$215.00
Progressive Repairable	87	85	$306.00			36	$285.00
	88	19	$390.00			26	$285.00

			NET		COMMERCIAL		ORGANIC
NSN: 5895-00-412-8615	FY	QTY	PRICE	QTY	DEPOT	QTY	DEPOT
COG & MCC 7EH	80					2	$342.00
SM&R PA2GD	84	10	$607.00	19	$429.00		
NEOF RATE 74.20%	85	17	$648.00			34	$161.00
23 of 29	86	34	$335.00				
Progressive Repairable	87	50	$340.00			13	$285.00
	88	18	$390.00			14	$285.00

AIMS MK XII IFF DECODER :

NSN: 5895-00-412-8618	FY	NET QTY	NET PRICE	COMMERCIAL QTY	COMMERCIAL DEPOT	ORGANIC QTY	ORGANIC DEPOT
COG & MCC 7EH	84	7	$259.00				
SM&R PA2GD	85	20	$648.00			16	$189.00
NEOF RATE 0.00%	86	42	$335.00			23	$261.00
0 of 1	87	46	$340.00			35	$285.00
Progressive Repairable	88	11	$390.00			14	$285.00

NSN: 5895-00-412-8620	FY	NET QTY	NET PRICE	COMMERCIAL QTY	COMMERCIAL DEPOT	ORGANIC QTY	ORGANIC DEPOT
COG & MCC 7EH	84	9	$607.00				
SM&R PA2GD	85	13	$303.00				
NEOF RATE 52.40%	86	17	$266.00			8	$190.00
11 of 21	87	29	$270.00			10	$305.00
Progressive Repairable	87					12	$295.00
	88	20	$418.00				

NSN: 5895-00-535-8247	FY	NET QTY	NET PRICE	COMMERCIAL QTY	COMMERCIAL DEPOT	ORGANIC QTY	ORGANIC DEPOT
COG & MCC 7GH	84	17	$193.20				
SM&R PA D	85	5	$198.00	5	$395.00		
NEOF RATE 60.00%	86	7	$352.00				
6 of 10	87	10	$357.00				
NO LONGER LISTED IN APL	88	1	$344.00				

NSN: 5840-01-084-8764	FY	NET QTY	NET PRICE	COMMERCIAL QTY	COMMERCIAL DEPOT	ORGANIC QTY	ORGANIC DEPOT
COG & MCC 7EH	83			53	$603.00		
SM&R PA2GD	84	3	$351.00				
NEOF RATE 29.00%	85	3	$311.00	6	$202.00		
2 of 7	86	27	$366.00	32	$529.00	9	$261.00
Progressive Repairable	87	62	$371.00	14	$780.00	7	$265.00
	88	18	$418.00	31	$305.00		

CV-3333 AUDIO CONVERTER :

NSN: 5999-01-042-3396	FY	NET QTY	NET PRICE	COMMERCIAL QTY	COMMERCIAL DEPOT	ORGANIC QTY	ORGANIC DEPOT
COG & MCC 7EH	84	12	$367.00				
SM&R PA2DD	85	35	$318.00				
NEOF RATE 44.00%	86	68	$453.00				
11 of 25	87	83	$459.00				
Depot/Depot Repairable	88	20	$442.00				

<u>AN/SQQ-23 SONAR :</u>

		NET		COMMERCIAL		ORGANIC	
NSN: 5845-00-450-1852	FY	QTY	PRICE	QTY	DEPOT	QTY	DEPOT
COG & MCC 7HH	82			14	$299.19		
SM&R PA5DD	84	5	$523.00	35	$264.59		
NEOF RATE 78.00%	85	12	$501.00			20	$315.00
14 of 18	86	28	$469.00	1	$128.00		$335.00
DEPOT/DEPOT REPAIRABLE	86			1	$ 68.00		
	86			1	$700.00		
	87	32	$476.00				$418.00
	88	2	$108.00				$400.00

<u>AN/WRN-5 RADIO NAVIGATION SET :</u>

		NET		COMMERCIAL		ORGANIC	
NSN: 5825-00-321-0671	FY	QTY	PRICE	QTY	DEPOT	QTY	DEPOT
COG & MCC 7HH	84	4	$1,130.00				
SM&R PA2DD	85	5	$770.00			4	$502.00
NEOF RATE 13.00%	86	12	$727.00			4	$519.00
4 of 30	87	19	$737.00			5	$435.00
DEPOT/DEPOT REPAIRABLE	88	16	$596.00			15	$515.00

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